

operative medical and laboratory supervision, will often result disastrously.

SUMMARY

1. The most important point about thyroid disease is recognizing goiter early before vital organ degeneration has taken place.

2. Next we must accurately differentiate the type of goiter and the degree of hyperthyroidism present in order to give the proper treatment.

3. The commoner types of goiter are:

(a) Colloid goiter (simple colloid hypertrophy, adolescent, diffuse colloid).

(b) Adenomatous goiter without hyperthyroidism (non-toxic adenoma).

(c) Adenomatous goiter with hyperthyroidism (toxic adenoma).

(d) Exophthalmic goiter (Graves' or Basedow's disease (hypertrophic parenchymatous thyroid)).

(e) Mixed goiter with hyperthyroidism.

4. Pathologic tissue examination divides the commoner types of thyroid glands into simple colloid goiter, exophthalmic goiter, adenomatous goiter and a combination of the last two, but fails to indicate accurately the clinical state of the patient in adenomatous goiter; *i. e.*, toxic or non-toxic, in a sufficiently high percentage of cases for practical use.

5. The administration of Lugol's solution produces a cystic and colloid replacement of the hyperplastic and hypertrophic parenchymatous cells in both toxic adenomata and true exophthalmic goiter glands.

6. Prevention of goiter by iodine administration is absolutely safe for school children, but dangerous for older people who may have adenomata in their thyroids. Therefore it should be given individually and not wholesale as in iodized salt or water.

7. Lugol's solution does not in itself cure exophthalmic goiter, being merely the most important adjunct to surgery or x-ray treatment. It should never be given to patients having non-toxic adenomatous goiters, but should be given to those who suffer from the adenomatous goiters with hyperthyroidism, and to patients with the mixed types, for a few days preoperatively for fear of an associated parenchymatous hyperplasia and hypertrophy.

8. A careful and conscientious cooperation between the surgical, medical and laboratory services is essential to the proper handling of thyroid disease, and such teamwork is seldom available outside of the large hospital or clinic.

9. A properly conducted and controlled basal metabolic rate machine is essential to the proper handling of disease of the thyroid unless one has had years of experience with such patients.

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REFERENCES

1. Mobius, P. J.: Ueber das Wesen der Basedow'schen Krankheit; *Centralbl. f. Nervenheilk* (Leipzig), Yr. 1887, Vol. 10, pp. 225-29.
2. Greenfield, W. S.: Some Diseases of the Thyroid Gland, *Lancet* (London), Yr. 1893, Vol. II, pp. 1493-97, 1553-55.
3. Kocher, G.: Ueber Jod basedow; *Verhandl. d. deutsch. Gesellschaft f. chir.* (Berlin), Yr. 1910, 39 2 Teil, 396-423.

4. Aschoff, L.: The Goiter Problem, *May Clinic Bulletin*, Yr. 1924, Vol. 5, No. 265.

5. Plummer, H. S.: The Clinical and Pathologic Relationship of Hyperplastic and Non-hyperplastic Goiter, *J. A. M. A.*, Yr. 1913, Vol. 61, pp. 650-51.

6. Wilson, L. B.: The Pathology of the Thyroid in Exophthalmic Goiter, *J. Asso. Am. Phys.*, Yr. 1913, Vol. 29, pp. 576-86.

7. Kendall, E. C.: Influence of the Thyroid Gland on Oxidation in the Animal Organism; *Chandler Lecture, Indust. & Eng. Chem.*, Yr. 1925, Vol. 17, p. 525.

8. Dubois, E. F.: Metabolism in Exophthalmic Goiter, *Arch. Int. Med.*, Yr. 1916, Vol. 27, p. 964.

9. Boothby, William: The Clinical Value of Metabolic Studies of Thyroid, *Boston M. & S. J.*, Yr. 1916, Vol. 175, pp. 564-66.

10. Plummer, H. S.: Studies in Blood Pressure I.—Blood Pressure and Thyrotoxicosis, *Tr. Asso. Am. Phys.*, Yr. 1915, Vol. 36, pp. 450-57.

11. Boothby, Walter M.: Personal Communication.

12. Rienoff, W. G.: The Histologic Changes Brought About in Cases of Exophthalmic Goiter by the Administration of Iodine, *Bull. Johns Hopkins Hosp.*, Vol. 37, Yr. 1925, pp. 285-705.

13. Giordano, Alfred S.: Histologic Changes Following Administration of Iodine in Exophthalmic Goiter, *Arch. Path. & Lab. Med.*, Yr. 1926, Vol. I, pp. 881-888.

14. McCarrison, R.: Thyroid Disease, *Brit. M. J.*, pp. 1065-69, June 13, 1925.

15. Marine, D., and Kimball, O. P.: The Prevention of Simple Goiter in Man (fourth paper), *Arch. Int. Med.*, Yr. 1920, Vol. XXL, pp. 661.

16. Plummer, H. S.: Personal Communication.

17. Boothby, Walter M.: The Use of Iodine in Exophthalmic Goiter; *Endocrinology*; November 24, 1924, Vol. 8, No. 6, pp. 727-45.

18. Crile, George W.: Surgical Treatment of Goiter (X-ray Treatment of Goiter vs. Surgical Treatment), *Radiology*, Yr. 1926, Vol. 6, pp. 365-99.

19. Wilson, L. B., and Kendall, E. C.: The Relationship of Pathological Histology and Iodine Compounds of the Human Thyroid, *Amer. J. M. Sc.*, Yr. 1916, Vol. 151, p. 69.

UNILATERAL SIGHTING*

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DISCUSSION by Roderic O'Connor, M. D., San Francisco; Frederick C. Cordes, M. D., San Francisco; P. Obarrio, M. D., San Francisco.

A REVISION of the current explanations of the physiological and optical phenomena of binocular vision is resulting from the recent work of Parson¹ and from that of the author,² on eyedness and handedness.

Sheard³ says, in discussing this work editorially, "Our clinical tests upon the elements of convergence, fusion powers and muscular insufficiencies are based upon the principle of triangulation, in which the line joining the nodal points of the two eyes—or interpupillary distance—serves as the base of the triangle, while the point of fixation is made to lie on a line drawn as perpendicular bisector to the base line so that the distances from the nodal point of each eye respectively to any point on the median line are equal. Binocular single vision is thus graphically diagrammed and discussed as though each of the two eyes was equally dominating and directing

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and that, as a result, the most accurate fixation, from the standpoints of ease, comfort and proper location in space of any object, would occur if the object fixed was located on the median line perpendicular to the ocular base line so that equal amounts of accommodation and equal amounts of actual turning in or convergence of each eye should be involved. In the bulk of cases no such ideally simple arrangement exists and equal division of labor probably is not present. In cases of right-eyed dominance simple tests show that, ordinarily, the object fixed is definitely located and sighted by the right eye, and that the visual triangle, insofar as binocular single vision is concerned, is a right-angled triangle with the right angle subtended at the nodal point of the right eye. The angle merely is reversed in left-eyedness.

The comparative constancy of this relation which exists between the right eye and hand, and the left eye and hand, in spite of binocular vision and of the projection of both maculae into both hemispheres of the brain, justly has provoked great speculative interest.

Many untenable explanations have been given, but the opinion usually held was that we are right-eyed because we are right-handed. Gould,⁴ in 1908, put forth the idea, widely accepted at the time, that "handedness depends upon which is the better-seeing eye." Parsons (q. v.), who is drawn upon freely here, took the subject out of the realm of speculation and for the first time placed it upon its factual feet by his demonstration of the optical necessity for unilateral sighting. He concluded that "handedness is caused by a functional limitation of binocular vision which necessitates the exclusive use of one eye for all sighting or aiming operations and therefore for many of the most important manual activities. The fact that these visual operations are carried on monocularly leads inevitably to the preferred use of one hand—the hand nearer the sighting eye" for the greatest anatomical and physiological advantage. "Every consideration of speed, accuracy and economy of muscular effort demands this intimate correlation of eye and hand on the preferred side."

It was my privilege to extend and amplify Parson's basic work by an independent and equally basic study² of the effects which eyedness, and posture⁵ resulting therefrom, produce in the position, muscular behavior and refractive state of the eyes, and of the greater susceptibility to refractive and pathological change seen in the non-fixing eye. Four groups of dextrals and sinistrals were identified in this study: (1) The pure dextral is right-eyed and right-handed. The left eye is cyclophoric and diverges when a test object is brought nearer than the convergence near point. About 76 per cent are pure dextrals. (2) The pure sinistral includes 9.3 per cent and is left-handed and left-eyed. The right eye is cyclophoric and diverges in the near test. (3) The crossed dextral is left-eyed but right-handed, usually by training. The right eye diverges in the test. About 13 per cent are included in this class and about 1.7 per cent in 4. the crossed sinistral, who is right-eyed but left-handed. The

left eye usually diverges upon test although the right may diverge.

It was shown in this study that the cyclophoric eye practically always is the non-fixing eye and therefore that the identification of cyclophoria at once gives the clue to the native state of eyedness and handedness.

It was further demonstrated that, while training, accident or disease may reverse the manuality of the individual, eyedness, *i. e.*, the exclusive use of either the right or left visual line for sighting, persists most tenaciously throughout life, requiring severe ocular disease early in life or practical blindness in adults to cause its reversal. This fixity of the unilateral sighting line under the most adverse conditions is additional proof of the dominance of the corresponding cerebral hemisphere and is wholly in keeping with that general asymmetry of structure and function of the limbs, brain and all the paired organs which distinguish man from all other primates, in whom monocular sighting fluctuates laterally as needed. It is interesting to note⁶ in this connection that the earliest known human fossil skull shows, by a cast of its brain case, a large lunate sulcus upon the left hemisphere, a reversal of what is normal in right-handedness and proving the original sinistrality of the individual. Riese,⁷ records the asymmetry of the surface markings of the brain of several prominent left-handed individuals in favor of the right hemisphere and states that in the case of a gifted left-handed artist, a considerable surface enlargement of the right occipital visual area was regarded as the anatomical expression of the drawing talent of the man. Riese states that "left-handedness and the corresponding domination of the right cerebral hemisphere are based on a definite anatomical organization of the brain." The mere reversal of manuality by training obviously cannot reverse this fundamental background.

The function of each eye in purposeful vision requires restatement and further emphasis. The dominant eye, variously called the fixing or fixating, the orienting, directing, dominant, master or sighting eye, as implied by its various names, has the main function of sighting in its own line of vision. Its fellow eye, with equal significance, has been named the non-fixing, non-sighting, deviating and especially the moving eye, all carrying movement as the chief idea. These original meanings referred to the separate actions of the two eyes in distance vision, but I have shown that these separate actions are even more apparent in the near test mentioned above when the aperture of a retinoscopic mirror is fixated and is carried nearer than the convergence near point. I know of no single, simple eye test which is more revealing than this one.

May I recall the facts of physiological diplopia: It has long been known that objects nearer than the point of fixation and the horopter surface connected with it have crossed images, while all objects beyond the point fixed have homonymous images. This diplopia exists constantly in man, the images of each eye reaching consciousness entirely separate and distinct but ordinarily without producing diplopia owing to suppression of

or lack of attention to the weaker image of the non-fixing eye. This may be shown by fixing an object five to eight feet away and in the median plane, with both eyes open. If either index finger is pointed at this object along the presumed line of sight the finger will be doubled heteronymously. On closing the eyes in turn the image of the finger is found interposed laterally, not mesially, along the line of sight of one eye, the right eye in the pure dextral and the left in the pure sinistral, regardless of which hand is used in pointing. Now if the gaze be shifted slowly from the point of attention to the finger itself, we note that the "double images in process of combining into a single image do not seek a midway fusion point, but that in the right-eyed the image belonging to the right eye remains stationary on the right visual line, *while that belonging to the left travels the entire intervening distance in order to unite with its fellow image.* In other words one of the heteronymous images is unmistakably a true one." It is apparent from this simple experiment and from other work of Parson, Duane⁸ and the author, that the particular function of the dominant eye in exact sighting is to give direction and position by fixating the object in its own line of vision. The task is given to the moving eye of converging to the extent of producing binocular single vision. This truly "moving eye" gives the final judgment of distance, dimension, depth and relief, the qualities of solid or stereoscopic vision, by means of the nervous impulse necessary to produce the needful degree of convergence and by the proprioceptive muscle sense involved in the actual movement. This difference in ocular movement can be seen at times on simple inspection of the test subject where there is moderate exophoria. A small but definite interval often is evident to the subject, in moving from one point of exact fixation to another a few feet away, before the non-sighting eye reinforces the master eye and the momentary indistinctness is overcome by fusion of the foveal images, and by the needful amount of accommodation. The impulse to fuse the two foveal images must be compelling in an apparatus so sensitive that adjustments of one-quarter of a degree between two visual lines can be detected with constancy and where visual acuity drops so sharply and rapidly away from the macula that it is only one-fifth of normal two and one-half degrees from the point of attention.

Sheard (q. v.) in discussing our work and its application to tests for ocular muscle tonicity, imbalance and its correction by prisms, confirms our own written opinion and that of Dolman⁹ and of Savage¹⁰ by his statement that "the distorting or dissociating device should always be placed before the non-fixing eye. By such a procedure the directing eye looks at the natural test object and definitely fixes it, while its mate, naturally accustomed to moving into coördination with the directing eye, will readily disclose its latency of error in this function of convergence coördination. If, on the other hand, the dissociating device is placed before the dominant eye and the naturally non-directing eye is allowed to attempt fixation of the

test object, a conflict of function immediately is set up and an uncertain, vacillating state of affairs is present."

THE RELATION OF UNILATERAL SIGHTING TO SPORTS

The relation of unilateral sighting to sports is of much interest and of some practical importance. Persons with right manuality often are discovered to be left-eyed by their indifferent or uncertain golf, shooting, tennis, baseball and other branches of sport. It is a foregone conclusion that in these games, played with both eyes open, the crossed dextral and sinistral classes are at an anatomical and physiological disadvantage compared with the pure dextrals and sinistrals, whose sighting line and preferred hand are on the same side and work together naturally. The intimate grouping of the principal motor centers is disarranged in the crossed classes and, in the transfer of part of their activities to the other cerebral hemisphere a certain amount of indecision and awkwardness often is apparent. So long as the crossed dextrals do not strain or press and merely use muscle sense and two-eyed vision they shoot and play games reasonably and at times very well, but when they become particularly anxious, by the very nature of ocular dominance, they must pick up their alignment with the left eye and miss widely to the left. In other words, when exact sighting is necessary, binocular vision is replaced by monocular vision and the sight is brought into line with the object by the master eye along its line of vision. The trained normal shot involuntarily falls into gun alignment by muscle sense after one-eyed alignment is made, the two actions almost blending. Those who shoot from the right shoulder but who are blind in the right eye have only the problem of visual acuity to deal with, as they have monocular vision and none of the distractions of physiological diplopia. The main disadvantage of obligatory monocular vision is that in shooting at a moving object this object must be sought for and realigned continually.

There is no reason why a left-eyed man cannot shoot from the right shoulder with accuracy if the left eye be closed, provided that his arm, hand and back muscle coördinations are equal. His success as a shot under such conditions depends merely upon his visual acuity. However, as the very fact of handedness presupposes inequality or imbalance in the shoulder girdle action, this skeletal imbalance makes for awkwardness and is the sole handicap. Rifle shooting is done, for the most part, with the moving eye closed and merely is a process of unilateral sighting in order to obtain exactness of aim. Here, other things being equal, the chief and almost the only determining factor in the relative ability to shoot from the right or left shoulder is visual acuity. Where rapid rifle fire without exact aim is necessary the visual problem is identical with that of the shotgun, *i. e.*, the rifle is put into alignment with the right eye in the right-eyed and with the left eye in the left-eyed regardless of the shoulder from which the rifleman shoots. Granting then

that a man has the temperament of a good shot, normal binocular vision and normal visual acuity, his success as a shot will depend upon the harmony of action of the corresponding eye and hand, or the lack of it. It is elementary optics that with both eyes functioning equally there is no such thing as accurate sighting.

Two other main points of interest have arisen out of this work. The first is that the determination of native handedness should be considered as an essential test in all orthopedic examination and especially in its application to the correction of postural defects. It is difficult to see how correct native skeletal and muscular balance can otherwise be restored in the 15 per cent of all patients who form the crossed dextral and sinistral groups.

Finally, my attention repeatedly has been drawn to the nervous instability of the children who make up these crossed groups. It may have been coincidental or of great significance that all of the choreic and choreiform children whom I have seen in the past nine years of this investigation have been crossed dextrals or have been frankly left-handed children in whom an attempt has been made to force them into full dextrality or a certain amount of it. The attempt never has been made, but it is here suggested that the deliberate re-education of this type of patient to frank left-handedness and full left-sided dominance, probably regardless of age, is a possible means of re-establishing nervous control.

The whole background of the matter of handedness is contained in Parson's statement, "It will be better understood if we conceive of the sighting line as belonging not to the eye and the hand but to the whole body." Considering then that the master eye is "the organism's sighting line," deviations from the inherited relation of eye and hand should be prevented in early childhood by the earliest possible recognition of what should be normal for the individual and by the maintenance of this normalcy.

SUMMARY AND CONCLUSIONS

1. The idea that a given object is sighted by both eyes along a line midway between the eyes, the effort requiring equal amounts of convergence and accommodation, optically is untenable.

2. One eye always dominates the other. The right eye is the master in the fundamentally right-sided, about 78 per cent, and the left eye in the fundamentally left-sided, about 22 per cent. This true ratio of right- and left-eyedness and handedness, 1 to 4, is concealed by training to right-handedness.

3. The line of sight is on the side of the dominant eye and, therefore, is right or left lateral. Manuality may be reversed by training, but the line of sight is fixed throughout life unless reversed by severe ocular disease early in life or by practical blindness of the master eye in adult life.

4. The two eyes have different functions in exact sighting, the dominant eye fixing the point of attention in its own line of vision, while the moving eye, by its actual movement of convergence to produce binocular single vision, giving

the final judgment of distance, dimension, depth and relief.

5. Right-handed persons often are discovered to be left-eyed by their indifferent or uncertain golf, shooting, etc. In all sports the crossed dextrals and sinistrals are at an anatomical and physiological disadvantage, as their sighting line and preferred hand are on opposite sides, disarranging the natural relation of the principal motor centers.

6. The determination of native sidedness (handedness and eyedness) should be a basic test in all orthopedic procedure concerned with the correction of postural defects.

7. Nervous and mental instability apparently is more common among the crossed dextrals and sinistrals than among the pure dextrals and sinistrals. The suggestion is made that the deliberate re-education of these classes to their natural full left-sided dominance may be an important factor in re-establishing nervous balance.

8. Native dominance of either side of the body should be recognized as early as possible and deviation from the inherited relation of eye and hand prevented.

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REFERENCES

1. Parson, Beaufort S.: *Left-handedness*. Macmillan Co., 1924.
2. Mills, Lloyd: *Eyedness and Handedness*, Am. J. Ophth., December, 1925.
3. Sheard, Charles: Editorial, *Unilateral Sighting and Ocular Dominance*, Am. J. Physiol. Optics, October, 1926, pp. 548-567.
4. Gould, G. M.: *Right-handedness and Left-handedness*. J. B. Lippincott Co., 1908.
5. Mills, Lloyd: *The effects of Faulty Craniospinal Form and Alignment upon the Eyes*, Am. J. Ophth., July, 1919.
6. Smith, G. E.: Brit. M. J., December 12, 1925, p. 1107.
7. Riese: Berlin Letter, J. A. M. A., January 1, 1927, p. 45.
8. Duane, A.: *Projection and Double Vision*, Arch. Ophth., New York, May, 1925.
9. Dolman, Percival: Am. J. Ophth., December, 1919, p. 867.
10. Savage, G. C.: *Precessional Volume*, Section on Ophthalmology, A. M. A., 1927, p. 180.

DISCUSSION

RODERIC O'CONNOR, M. D. (909 Hyde Street, San Francisco)—Doctor Mills very considerably sent me his paper to read knowing probably that it could not be properly discussed offhand simply from hearing it. This gives me the opportunity to take up each heading as he covered it.

1. Convergence. The non-fixing does not always fail first in this test. Vertical deviations, apparent or hidden, have much to do with convergence, and I have seen many apparent cases of insufficiency of convergence disappear on correcting the vertical deviation by prism or, if of high degree, by operation.

2. As regards the non-fixing eye being the one to give us ideas of distance, perspective, etc. In 1910, while a Major in our regular Medical Corps, I published a paper on "The Relations of the Eyes to Rifle Shooting" in which I mentioned the question of the dominating eye as follows: "The judgment of absolute distance by the aid of convergence is very uncertain, but the ability to tell whether one object is farther than another by the amount of convergence necessary to maintain binocular vision is very acute. This is so because in binocular vision the lines of vision intersect at the object seen. Therefore the slightest difference

in distance must be appreciated in order to maintain binocular vision. This brings up the question, does one eye do all the converging or do both eyes converge equally? And this in turn brings us to a consideration of the dominating, fixing, or sighting eye. About the same proportion of people are right-eyed as are right-handed, and this may account for the occasional man who is unable to shoot from the right shoulder because the left is his sighting eye; and this in spite of normal vision in the right eye. One can easily determine which is the sighting eye by aligning, with both eyes open, the point of a pencil on a mark. While doing so close each eye in turn and the one that maintains the alignment is the sighting eye. In the vast majority of people it is the right eye. Now if, while holding the point on the mark the focus is changed to the point which produces convergence to that extent, the mark still being seen hazily, and then the non-sighting eye is closed, it will be found that the alignment is still maintained. This would appear to prove that the non-sighting eye did all the converging while the sighting eye kept the same line of fixation. The advantage of this is evident—the entire muscular effort is appreciated by one group of muscles instead of being divided between two groups, which would mean a finer judgment." This experiment is practically the same as that given by Doctor Mills to prove the same point.

3. As regards the eye before which to place the Maddox rod. I always make two tests, one with each eye fixing in order to find any tendency to non-comitancy (paresis). In the absence of such it is rare to find an appreciable difference in the results. But then, as shown by Marlow and myself in our work with prolonged monocular occlusion, tests as ordinarily made are worthless in the diagnosis of muscular conditions in kind, degree, or even presence. My findings in 110 orthophoric cases, with symptoms, as given at last year's meeting of the Academy of Ophthalmology and Otolaryngology, proves this conclusively.

4. Eyedness in sports. Aside from rifle shooting I have thought of this in connection with golf. About two years ago I called attention to this matter in a short communication in *The Fairway*. It was in answer to a statement by a leading professional to the effect that the left eye was the one to "keep on the ball" as the backswing would carry the head so far around that the nose would interfere with the sight of the ball by the right eye. My contention was that the head must not turn so far as to prevent a sight of the ball by both eyes and that both must be "kept on the ball" in order to permit accurate judgment of distance, etc.

5. As regards orthopedic considerations. I have had no experience in this connection. I have, however, in ordinary imbalances and have relieved many cases of head tilting with accompanying lowering of corresponding shoulder, also blinkers and facial contorters by prismatic or other correction of evident muscle deviations as well as those diagnosed by aid of prolonged monocular occlusion.

6. As to his conclusions. I agree absolutely with his first five, and admit lack of qualification to even express an opinion as to the last three. The question of the fixing eye comes up in my daily work in the following connections:

1. In using prolonged monocular occlusion in the hunt for a hidden deviation, and in making a complete diagnosis of an evident one, the non-fixing eye is the one occluded.

2. In the treatment of the lower degree of deviations by prisms. In most cases I divide the prism strength equally between the two eyes and give a full correction of any vertical. Only in definitely parietic cases do I give a greater or total allowance to one eye, the reason being that prisms change strength with angle of gaze through them. If of equal strength the increase in one keeps pace with the decrease in the other, so that the total remains the same, thus suiting comitant cases in all directions of gaze. In this connection, therefore, I do not agree with Sheard, who

suggests placing the entire prism strength before one eye—the non-sighting.

3. In relation to operative work on ocular muscles. Subject, of course, to the general principle of finding the weak muscle and of improving its power to act I try to bring eyes to parallel by working on the non-fixing eye. This cannot be done always. Cases of parietic superior rectus frequently fix with that eye adjust the position of the head to relieve the weak muscle (tilt, chin up, chin in) and either bring the other eye to parallel or permit it to go far out of position. This occurs in some cases of upshoot of one eye (spasm of its inferior oblique) associated with paresis of the superior rectus of the other eye. At the San Francisco A. M. A. meeting I demonstrated such a case in which an upshoot with inward squint of right eye was corrected by shortening the superior rectus of the left, proving the importance of finding the muscle at fault in order to avoid treating cases by rule of thumb measures, which is done too often in strabismus work. Much harm would have resulted in this case from tenotomy of the internal rectus.

The day this discussion was written two left-eyed patients were seen. One was practically emmetropic and said she was right-handed, but admitted doing some things with the left hand. The other was definitely right-handed, but had a three-diopter myopic astigmatism in the right eye not corrected till the fourteenth year. The first may have been educated out of a left-handed tendency, while the second probably was educated into left-eyedness by reason of poor vision in the right.

In conclusion I wish to compliment Doctor Mills on the results of his work, for I am in a position to understand how much time it must have taken to gather the records from which he drew his conclusions. Also to thank him for the compliment of asking me to open the discussion of a subject that is of far greater importance than would appear on superficial consideration.

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FREDERICK C. CORDES, M.D. (384 Post Street, San Francisco)—The work of Parsons and that of Mills on eyedness and handedness has revised our idea of the mechanism of binocular vision. Reik contended this was merely a repetition of Gould's theory, which was that dominance is an adjustment due to imperfect function. Parsons' theory—and this is sustained by Mills—is that lateral sighting is a basic physical necessity due to peculiarities of our body structure and that it is an inherited tendency.

In the present paper on unilateral sighting, Mills brings out some factors that remove the subject from the theoretical field into the practical one.

The relation of unilateral sighting to sports is an interesting one and explains certain difficulties encountered in patients who complain of their inability to play golf or shoot, particularly when under stress.

Doctor Mills' observations in choreic and choreiform children is, it seems to me, an important one. The determination of the fixing eye is so simple that it might be valuable to check this on all cases of this type in the various children's clinics. Should the above observations be borne out it would be important that parents be instructed not to attempt re-education in left-handed children so as not to add one additional factor in the possible production of nervous instability.

The placing of prisms before the non-fixing eye in vertical muscle imbalance (or if the amount must be divided, placing the larger amount over the non-fixing eye) should also be kept in mind.

I feel the future of this work offers many possible practical applications.

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P. OBARRIO, M. D. (350 Post Street, San Francisco)—I wish to thank Doctor Mills for giving me the opportunity of discussing his very interesting paper at leisure with the original at hand. I regret very much, nevertheless, that the limitation of five hundred words placed on any discussion is a handicap very hard to overcome, as the very nature of the subject, plus the

description of experimental data, naturally covers considerably more space.

I have, therefore, discussed the subject in detail, using about twelve pages of typewritten material, which I have placed in the hands of Doctor Mills.

The proper experimental lay-out is given in detail as well as the manner of conducting experiments that conclusively show that the matter of "handedness," as described by Doctor Mills, does not affect the basic principles concerning the production of experimental diplopia.

That in the median line the duplication of images is absolutely symmetrical.

That the slight lateral deviation of the near object will, of course, produce a slight displacement explaining the so-called right or left "handedness."

That the contention of the author to the effect that "one of the heteronymous images is unmistakably a true one" is demonstrated to be optically impossible, for in order that an image be a true one, rays of light must be exactly focused at the fovea. It is evident then that neither one of the heteronymous images is a true image not even at the time when the white target is in alignment with the black target and the eye, for at this moment the image is reproduced in the region of the macula but by circles of diffusion, and in order to procure a true image you must accommodate also, which entails in this case a converging action with immediate disappearance of the double images.

I must also differ from the author as regards his first conclusion, to the effect that "the idea that a given object is sighted by both eyes along a line midway between the eyes, the effort requiring equal amounts of convergence and accommodation, optically is untenable," for I have on the contrary demonstrated that this action is not only tenable but optically and physiologically correct.

Now as to the relation of sight in sports I claim that, generally speaking, the question of sight is of relatively secondary importance throughout the whole realm of sports and that the matter of muscle coordination, quick perception, adaptability, responsiveness, reaction to surroundings, temperamental nature and what not, plus other items, with or without regard to "handedness," constitute a proficient player, and among these the champions are the few gifted and inspired.

The creator of a symphonic poem, an immortal poet, or a clever acrobat, all seem to perform without apparent effort.

An analysis of their mode of procedure is a difficult task at best.

After writing the above I have the authority of no less a person than Bobby Jones, writing in the *Oakland Tribune* of September 30, 1927, in which he states that: "I have been asked several times what part of the ball I looked at when playing golf. In answer I have always said that I did not look at it at all, but was merely conscious of its presence. And I have tried, too, as an experiment to gaze fixedly at the ball throughout the swing, and every time, without exception, I have dug up huge masses of turf behind the ball.

"When I top a shot it is because my swing is out of its customary rhythm, usually because I am fearful of some other mishap. A quick, spasmodic back swing is ordinarily the beginning, followed by a snap at the ball which carries my shoulders up and the club out of its normal path. And there is no better cure for topping than a slow back swing. The comfortable, well-timed stroke, very rarely catches the ball above center."

This then is the gist of vision as applied to golf. I can mention several instances of a similar nature regarding trap shooting and other sports.

My records show cases of total loss of one eye; of very marked astigmatic errors with notable diminished vision in one or both eyes, etc.; cases where stereoscopic vision is out of the question. These cases

being considerably better than average at different sports, notably golf.

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DOCTOR MILLS (closing)—In answer to Doctor O'Connor: The non-fixing eye always yields first in my fixation tests inside the near point except in cases of esophoria where it may be necessary to use the Maddox rod, rotary prisms, or the clinoscope to determine the cyclophoric eye. It is a matter of importance that in myopia the fixing eye usually is more myopic, and myopia appears earlier than the non-fixing. The reverse appears true in hyperopia, and these apparent discrepancies, associated with the differences in ocular dominance and manuality, have confused many who have been interested in the subject of changes of refraction. These conditions really form the background upon which refraction changes are based.

I had the pleasure, in my first paper on this subject, of bringing Doctor O'Connor's paper into the literature of eyedness and handedness. In common with Savage and several others, here and abroad, he came close enough to the explanation of ocular dominance to have made his non-recognition of it a matter of regret.

Of course Doctor O'Connor now probably would correct his statement that "About the same proportion of people are right-eyed as are right-handed." The facts are that about ninety-two in one hundred are right-handed and about seventy-eight in one hundred right-eyed, a difference of about 15 per cent, which form the troublesome crossed classes.

With regard to placing a prism preferentially before the cyclophoric eye: In nearly every eye the superior obliques are weaker than the inferior obliques. Prisms base down before the hyperphoric eye call the superior oblique into action, thus helping the superior oblique of that eye to parallel the vertical axis with that of the median plane of the head. If a prism is placed base up before the fixing eye, however, its inferior oblique is called into action, thus throwing additional work on its naturally too weak superior oblique and exciting discomfort. Savage states that weakness of the superior oblique is two hundred times more common than weakness of the inferior oblique. For this reason I feel that a corrective prism should be placed entirely before the non-fixing eye where the vertical deviation is two degrees or less and that a larger amount should be placed before this eye where it is necessary to split the prism in higher degrees of error.

Many thanks are due Doctor O'Connor for bringing out the practical value of the tests for ocular dominance.

Doctor Obarrio's comments on the subject of physiological diplopia are drawn from an interesting report of experiments done by him which he was kind enough to send to me. This report is somewhat longer than my own original paper, and as it presents data which have never been confirmed and which are wholly at variance with the work of practically all recent authorities, it would appear unwise either to draw conclusions or to make critical comment until such confirmatory evidence is at hand.

Doctor Obarrio's conclusions go back to the anciently held idea of the cyclopean eye which pays no attention to the great law of corresponding points which is back of all binocular phenomena.

His paper has been sent to Doctor Parsons for appropriate testing and report.

The proof of the findings of my near test for "eyedness" is that it works in daily practice and correlates the evidence given by the different forms of hyperphoria, cyclophoria, muscle imbalance, larger refractive errors and disease into a complete and easily understood picture.

With regard to the function of the eyes in sports, it is evident that superexcellence in any sport demands what I have called in shooting "the temperament of a good shot." Without this no local harmonies of function will ever lift the individual above mediocrity in play or work.

The numerous cases of persons having monocular

vision who have excelled in sports clearly show the adaptability of the brain and eye to new conditions.

With monocular vision, distances and localizations are gauged by the physiological double images registering on the retina outside of the macula, by the relative sizes of objects, by the parallactic displacement of objects in the foreground on those more remote, and by the effects of contrast, *i. e.*, light, shade, and distinctness. Experience is the final factor which fixes these varying values according to individual ability.

HUNTINGTON'S CHOREA—SOME PATHOLOGICAL STUDIES*

WITH CASE REPORTS

By WALTER F. SCHALLER, M. D.

DISCUSSION by Thomas G. Inman, M. D., San Francisco; Samuel D. Ingham, M. D., Los Angeles; Glanville Y. Rusk, M. D., San Francisco.

IN neurological research it is now the fashion to investigate the motor system. Studies have taken a trend along the different lines of the old motor system, the corpus striatum and related structures in the subthalamic region and the brain stem; and of the sympathetic system.

INTRODUCTION

This paper aims to discuss briefly some of the current ideas on the mechanisms of corpus striatum disorders, and to report pathological findings in three cases of Huntington's chorea.

Ramsay Hunt in May, 1916, presented a paper before the American Neurological Association on the "Syndrome of the Globus Pallidus" in which he defined the pathology in a case of juvenile paralysis agitans as due to atrophy of the large motor cells of the globus pallidus. In four cases of Huntington's chorea which he also studied he found these large cells well preserved, but also found a wholesale destruction of the smaller cells of the neostriatum (putamen and caudate). Oskar and Cecile Vogt, from a large experience in pathological brain research, have formulated the hypothesis that lesions of the neostriatum are accompanied by tremor, chorea and athetosis, and lesions of the globus pallidus are accompanied by rigidity. The neostriatum is a terminal organ, and there is no direct connection between it and the cerebral cortex and no spinal projection system. Fibers from the neostriatum go to the globus pallidus and are inhibitory or steadying in function. A destroying lesion of the neostriatum, therefore, is a release phenomenon, permitting a globus pallidus hyperkinesia, as of tremor in paralysis agitans. In severe lesions of the globus pallidus there occurs a rigidity from dominance of the tonus centers of the hypothalamus and brain stem to which the globus pallidus sends a projection system, principally by the ansa lenticularis and the lenticular bundle of Forel. These fibers are largely medullated at birth; on the other hand the striopallidal fibers are not medullated even in an infant of five months. It is therefore possible, according to the Vogts, to draw an analogy be-

tween the uncontrolled movements of infants and those suffering from chorea. The obvious explanation in both cases is a lack of neostriatal control.

The Vogts have further elaborated their theory by the effect of the different pathological processes at work in the neostriatum. The state of disintegration (*état de désintégration*) being a milder process, causes tremor; whereas a fibrous state (*état fibreux*) or gross lesion, being a more severe process, produces choreic movements. The fibrous state is an elective necrosis of the ganglion cells and of the finest nerve fibers, with the crowding together of the large medullated fibers, causing a striking picture.

From a large clinical experience S. A. K. Wilson has made some penetrating observations in this subject. In the disease described by him, progressive lenticular degeneration, tremor and rigidity are both early symptoms, the globus pallidus being intact. Tremor and choreo-athetosis are very different in type, and it is inconceivable that they should be caused by the same lesions. Numerous instances have been reported in which tremor and choreo-athetosis have occurred with an intact corpus striatum. Choreo-athetosis, according to Wilson, is due to a lesion on the afferent cerebello-mesencephalo-thalamo-cortical paths. Wilson criticizes attempts to localize with precision the different clinical syndromes, and feels that these localizations are not justified by the present state of our knowledge of anatomy and physiology.

Of the distinguished workers in this field the names of Charles Foix of Paris and of A. Jacob of Hamburg should not be omitted. The latter investigator believes that athetoid movements in the adult are found only in globus pallidus lesions. Lesions in the corpus luyi produce tortion spasm (*corpus luyi plus putamen*. Thomallas case reported by Vogt). Lesions of the substantia nigra determine Parkinsonian rigidity.

HUNTINGTON'S CHOREA (CHRONIC CHOREA)

George Huntington of Pomeroy, Ohio, in the *Medical and Surgical Reporter* for April, 1872, described the disease which bears his name. His classical and lucid description has not been since improved upon. Huntington stressed the cardinal symptoms of a progressive chronic chorea in adult life, with a hereditary predisposition and tendency to insanity and suicide. Properly speaking, Huntington's chorea should be applied strictly to those cases of hereditary origin with psychic effect, but the term is now frequently applied to chronic adult chorea in contradistinction to the acute childhood form, or Sydenham's chorea. Arthur S. Hamilton in the *American Journal of Insanity* for January, 1908, analyzed twenty-seven cases of chronic progressive chorea. He states: "I can see no means of diagnosing accurately between chronic progressive chorea with hereditary predisposition and chronic progressive chorea without hereditary predisposition. To me they seem the same disease."

Glanville Y. Rusk, in the same journal for July, 1902, has written an important article on the

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